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PROCEEDINGS OF THE DEFORMATION STUDY GROUP, CALEDONIDE OROGEN PROJECT

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INTRODUCTION

The NATO Advanced Study Institute - IGCP Caledonide Orogen Project Meeting in Fredericton, New Brunswick, Canada, in August 1982, provided the opportunity for members of the Deformation Study Group to compare structural maps of various parts of the Caledonide Orogen. This allowed the legends to be standardized, for some general conclusions to be made about the spatial distribution, nature and trends of structures throughout the entire orogen and for some preliminary hypotheses to be formulated about their origin. These are presented here.

The structural maps of various parts of the Caledonide Orogen show the age, orientations and spatial distributions of major structures. To date, the only published map is the Structural Map of the Appalachian Orogen in Canada (1). Others are in various stages of preparation and generalized small scale black and white versions are presented elsewhere in this volume. In general, on the coloured maps, background colours indicate the time of the first deformation. The intensity of penetrative deformation is shown by different shades of the backgound colours, the darker shades representing higher strain. Ideally, the time of deformation is constrained by stratigraphic information. However, in many areas the

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constraints are limited to isotopic age determination data. In this context, a preliminary standardized time scale was agreed upon as follows: Precambrian-Cambrian boundary at 570 Ma, Cambro-Ordovician boundary at 520 Ma with the Tremadocian Stage placed in the Ordovician Period, Ordovician-Silurian boundary at 435 Ma, Siluro-Devonian boundary at 415 Ma, Devono-Carboniferous boundary at 360 Ma, Permo-Carboniferous boundary at 290 Ma and Permo-Triassic boundary at 250 Ma. While this differs slightly from that used on the Structural Map of the Appalachian in Canada, it does not affect the colours assigned to the times of deformation.

CONCLUSIONS

Based upon the structural maps and tables showing the times of deformation in various parts of the orogen, five major periods of deformation may be recognized within the orogen as a whole Late Proterozoic-Early Cambrian (Cadomian-Avalonian-Panafrican), Late Cambrian-Early Ordovician (Grampian-Finnmarkian-Penobscotian), Mid-Late Ordovician (Taconian), Siluro-Devonian (Late Caledonian-Scandian-Acadian), and Permo-Carboniferous (Hercynian-Alleghanian).

The Late Proterozoic-Early Cambrian, Cadomian-Avalonian-Panafrican deformation (650-550 Ma) is limited to the south-eastern side of the orogen, excluding the Baltic Shield. It varies rapidly in intensity with narrow anastamosing and branching zones of intense deformation separated by blocks with weak deformation. The temporal coincidence of Cadomian deformation with rifting and the opening of Iapetus along the margins of the Laurentian and Baltic Shields suggests that these events occurred along the margins of different oceans, one tensional (Iapetus) and the other compressional.

The Late Cambrian-Early Ordovician, Grampian-Finnmarkian-Penobscotian deformation (530-490 Ma) appears to have occurred along or near the margins of Iapetus. The intensity of this deformation increases from mild in the northern Appalachians to intense in northwestern Ireland, northern Scotland, and western and northern parts of Scandinavia. In general, the rocks affected by this event were subsequently thrust over the cratonic margins.

The Mid-Late Ordovician (Llanvirn-Ashgill), Taconian deformation (470-435 Ma) is mainly restricted to the northwestern margin of the Appalachians, but it occurs locally in western Ireland and is inferred in the northern part of the Mauritanides. In the Appalachians, the Taconian deformation may be attributed to subduction in part oblique to the cratonic

margin, terminating in volcanic arcs and trenches in Atlantic Canada and Eire.

The Mid-Silurian-Early Devonian, Late Caledonian-Ligerian-Scandian-Acadian deformation (425-400 Ma) is widespread throughout the Appalachians and Caledonides but is absent from the Mauritanides. The distinction between the Mid-Late Silurian Late Caledonian (Scandian) Orogeny and the Early-Mid Devonian Acadian Orogeny may be due to diachronism and/or differences in the dating method and different ages assigned to the Siluro-Devonian boundary. Thus, in the British Isles, the time of Late Caledonian deformation is bracketed by the youngest deformed strata of Mid and Late Silurian age and the oldest post-tectonic plutons yielding isotopic ages of 400-415 Ma. Here, post-tectonic strata are usually continental and poorly dated. However, in the northern Appalachians, post-Acadian plutons yielding similar ages cut deformed fossiliferous Early Devonian rocks. In the Scandinavian Caledonides, rocks as young as Downtonian are involved in the Late Caledonian deformation. Such comparisons lead to the conclusions that the Late Caledonian, Scandian and Acadian Orogenies are temporal equivalents and are correlatives along strike with little recourse to diachronism. The Late Caledonian-Acadian deformation varies considerably in intensity along the belt. It is most intense in Scandinavia, Newfoundland and New England and is of moderate intensity in Britain, Eire, France, Spain and Maritime Canada where there are local zones of intense deformation surrounding less deformed blocks. The deformation may be attributed to the closing of Iapetus in the northeast and the collision associated with the accretion of Avalonian terranes in the southwest.

The Permo-Carboniferous, Hercynian-Alleghanian deformation (350-250 Ma) was most intense in the southern and central Appalachians and in the Mauritanides. Northeast along the orogen, zones of Hercynian deformation splay out into zones of intense deformation surrounding mildly deformed blocks. This deformation is related to the collision of Africa and North America.

Several general observations regarding the nature of deformation in the Caledonide Orogen are as follows. The widespread deformational events appear to be relatively short-lived fabric-forming events followed by transpressive deformation, and may be attributed to a series of collisions as terranes are accreted with the cratons and with one another. Deformation during several of these events was clearly diachronous. Exceptions occur in (i) interpreted trench complexes such as the Southern Uplands of Scotland and part of the Merrimack Synclinorium where deformation is related to long-lived subduction and the formation of an accretionary wedge and (ii) areas where mechanisms involve gravity sliding and spreading.

Where large scale overthrusting occurs, such as in the southern and central Appalachians, the Mauritanides and the Scandinavian Caledonides, the deformational front does not coincide with the cratonic margin. In some places, such as the northern Appalachians, the deformational front appears to coincide with the edge of the craton.

Variations in the intensity of the various deformational events in the Caledonide Orogen provide some constraints upon palinspastic reconstructions for terranes involved in the accretionary collisions.

REFERENCE

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